REMARKS

Reconsideration of the application is respectfully requested.

I. Status

According to the Examiner, the present Office Action is responsive to a communication filed by the Applicants on December 8, 2008. However, Applicants respectfully submit that no papers were filed with the U.S. Patent and Trademark Office on December 8, 2008 in connection with the present application.

II. Status of the Claims

According to the Examiner, only claims 1-3 are pending in the present application. However, claim 4 was added as a new claim in a Preliminary Amendment filed along with the present application on June 8, 2006. Attached as Exhibit A is the Preliminary Amendment filed on June 8, 2006, along with a copy of the Electronic Acknowledgement Receipt ("EAR") noting receipt of a preliminary amendment by the USPTO.

Claims 1-4 are currently pending

Claim 1 is amended herein. No new matter is added.

III. Claim Rejections Under 35 U.S.C. § 112

Claim 1 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

According to the Examiner, "a number of teeth is equal to or more than 6 and equal to or less than 15," as recited in claim 1, is unclear. Claim 1 is presently amended to recite "wherein said drive gear has at least 6 and no more than 15 teeth." Accordingly, Applicants respectfully request that the rejection be withdrawn.

IV. Claim Rejections Under 35 U.S.C. § 103

Claims 1-3 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent No. JP 11-124045 to Shibayama Kazuya ("Kazuya") and the Examiner's statement of ordinary skill in the art. Attached as Exhibit B is a machine translation of Kazuya retrieved from the Japanese Patent Office on April 3, 2009. Applicants respectfully traverse the rejections.

With respect to claim 1, the Examiner contends that Kazuya discloses:

> a motor-driven power steering apparatus in which a rotating torque of an electric motor 33 is transmitted to a steering shaft 2 by a drive gear 21 provided in an output shaft 34 of said electric motor and a driven gear 20 provided in said steering shaft, and a speed reduction ratio is equal to or more than 3, wherein said steering shaft and the output shaft of said electric motor are arranged in almost parallel as shown in Fig. 1.

Additionally, although the Examiner admits that Kazuya does not explicitly disclose the claimed range of the center distance between the steering shaft and the output shaft, or the ranges of the module, tooth depth, pressure angle, and torsion angle of the drive gear, the Examiner contends that:

> it would have been obvious to a person of ordinary skill in the art to ... include [a center distance between two shafts is equal to or more than 35 mm and equal to or less than 90 mm, and said drive gear is configured such a module is equal to or more than 0.8 and equal to or less than 1.5, a tooth depth is equal to or less than 2.4 times of the module, and a pressure angle is equal to or more than 14.5 degrees and equal to or less than 30 degrees, and a torsion angle is equal to or more than 0 degree and equal to or less than 40 degrees] with the power steering apparatus of [Kazuya] to allow for the best mode of operation thus helping in reducing the wear and tear allowing for the longevity of the apparatus.

Applicants strongly disagree with the Examiner's contention that the claimed ranges of the center distance, module, tooth depth, pressure angle, and torsion angle would have been obvious to one of ordinary skill in the art at the time of the present invention.

Kazuya discloses a motor-driven power steering apparatus of a small size, which uses a gear with a tooth profile based on a predetermined special theory because it is difficult to secure the strength of a gear having a normal involute tooth profile in this application. (Specification, Page 3,

Line 23 – Page 4, Line 2). However, it is difficult to manufacture the tooth profile based on the predetermined special theory. (Specification, Page 4, Lines 6-9). Additionally, the performance of the speed reducer described in Kazuya is strongly affected by the alignment error of the gear, which necessarily is affected by manufacturing processes. (See Specification, Page 4, Lines 10-13). Accordingly, high precision processing and assembly is needed to manufacture a gear with a tooth profiled based on the predetermined special theory. (Specification, Page 4, Lines 13-15).

To overcome these problems, Applicants have invented a power steering mechanism that can achieve a predetermined speed reduction ratio even when the steering apparatus is constituted by a pair of spur gears or helical gears based on a simple structure, i.e., without the tooth profile based on the predetermined special theory disclosed by Kazuya. (See Specification, Page 4, Line 20 – Page 5, Line 1). Applicants have found that, contrary to the teaching of Kazuya, it is possible to secure correct values of trochoid interference clearance, tooth thickness of the tooth tops, and tooth surface stress without the need to include the difficult to manufacture predetermined special tooth profile. (See Specification, Page 6, Lines 1-8).

The Examiner's conclusory statement that the claimed ranges of the center distance, module, tooth depth, pressure angle, and torsion angle would have been obvious to one of ordinary skill in the art is not sufficient to establish *prima facia* obviousness. "The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious." (MPEP §2141). "[R]ejections on obviousness cannot be sustained with mere conclusory statements." (MPEP §2141, quoting *KSR International Co. v. Teleflex Inc.*, 82 USPQ2d 1385 (2007)). Moreover, a "mere statement that the claimed invention is within the capabilities of one of ordinary skill in the art is not sufficient by itself to establish *prima facia* obviousness." (MPEP §2143.01). The Examiner admits Kazuya does not explicitly disclose the claimed range for the center distance between the steering shaft and the output shaft, or the claimed ranges for the module, tooth depth, pressure angle, and torsion angle of the drive gear. Further, the Examiner provides no basis whatsoever for substantiating the alleged obviousness of the aforementioned limitations. Therefore, Applicants respectfully submit that the Examiner has not established *prima facie* obviousness for independent claim 1.

"If the examiner is relying on personal knowledge to support the finding of what is known in the art, the examiner must provide an affidavit or declaration setting forth specific factual statements and explanation to support the finding. See 37 CFR 1.104(d)(2)." (MPEP §2144.04) Although the Examiner does not specifically take Official Notice that the aforementioned limitations would have been obvious to one of ordinary skill in the art, Applicants traverse the Examiners' finding and demand that the Examiner provide a signed affidavit or declaration setting forth specific factual statements and explanation to support the finding as required by 37 CFR 1.104(d)(2).

Applicants respectfully submit that claim 1 is not obvious in view of Kazuya. Kazuya does not teach, suggest, or disclose a steering shaft and an output shaft that are almost parallel and wherein the center distance between the shafts is equal to or more than 35 mm and equal to or less than 90 mm, as required by claim 1. Further, Kazuya does not teach, suggest, or disclose a drive gear wherein "the module of said drive gear is equal to or more than 0.8 and equal to or less than 1.5, a tooth depth of said drive gear is equal to or less than 2.4 times of the module, a pressure angle of said drive gear is equal to or more than 14.5 degrees and equal to or less than 30 degrees, and a torsion angle of said drive gear is equal to or more than 0 degrees and equal to or less than 40 degrees," as recited by claim 1. Applicants respectfully submit that the Examiner provides no basis whatsoever for substantiating the alleged obviousness of the aforementioned limitations. Accordingly, Applicants submit that a drive gear for use in a power steering system having these characteristics would not have been obvious to one of ordinary skill in the art at the time of the invention.

Moreover, Applicants submit that Kazuya teaches away from using a drive gear according to claim 1 by disclosing that the tooth profile based upon the predetermined special theory is needed to increase torque transmission efficiency, decrease motor output torque, and miniaturize the motor of the power steering system. (See Kazuya, Machine Translation, Detailed Description [0031]). Thus, Kazuya not only does not disclose a gear having the claimed characteristics, but also teaches that a gear having a different tooth profile based upon a predetermined special theory should be used to achieve the desired properties.

In view of the foregoing, Applicants submit that Kazuya does not disclose all of the limitations of independent claim 1. Applicants further submit that a drive gear for use in a power steering system having the claimed characteristics would not have been obvious to one of ordinary skill in the art at the time of the invention and that the only reference cited by the Examiner teaches away from using such a drive gear in the claimed power steering system. Thus, Applicants respectfully submit that claim 1 is not obvious in view of the reference cited by the Examiner. Accordingly, Applicants respectfully request that the rejection be withdrawn.

Moreover, Applicants submit that claims 2-4 are allowable at least by reason of dependency upon an allowable base claim because they are dependent upon claim 1. Consequently, Applicants submit that the present invention is both novel and inventive over the cited reference and respectfully request that the rejections be withdrawn.

CONCLUSION

In view of the foregoing, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

The Examiner is respectfully requested to contact the undersigned at the telephone number indicated below if the Examiner believes any issue can be resolved through either a Supplemental Response or an Examiner's Amendment.

It is believed that all appropriate fees are included with these submissions. Should the U.S. Patent and Trademark Office determine that additional fees are owed or that any refund is owed for this application, the Commissioner is hereby authorized and requested to charge the required fee(s) and/or credit the refund(s) owed to our Deposit Account No. 04-0100.

Dated: **April 24, 2009**

Respectfully submitted,

By _____
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Attorneys/Agents For Applicants

EXHIBIT A

OIPE
APR 24 2009
PATENT & TRADEMARK OFFICE

Electronic Acknowledgement Receipt

EFS ID:	1071665
Application Number:	10596285
Confirmation Number:	4944
Title of Invention:	MOTOR-DRIVEN POWER STEERING APPARATUS
First Named Inventor:	Yoshikazu Kuroumaru
Customer Number:	07278
Filer:	Flynn Barrison/Hiroko Lavietes
Filer Authorized By:	Flynn Barrison
Attorney Docket Number:	20708/0204992-US0
Receipt Date:	08-JUN-2006
Filing Date:	
Time Stamp:	12:29:48
Application Type:	U.S. National Stage under 35 USC 371
International Application Number:	PCT/JP04/17790

Payment information:

Submitted with Payment	yes
Payment was successfully received in RAM	$900
RAM confirmation Number	636
Deposit Account	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part	Pages

1	Transmittal letter	00767899.PDF	57811	no	3
Warnings:					
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Information:					
2	Application Data Sheet	00767847.PDF	20245	no	3
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Oath or Declaration filed	00767902.PDF	100312	no	4
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
4	Documents submitted with 371 Applications	00767869.PDF	85362	no	17
Warnings:					
Information:					
5	Drawings	00767910.PDF	50484	no	5
Warnings:					
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Information:					
6		00767906.PDF	40014	yes	4

Multipart Description

Doc Desc	Start	End
Preliminary Amendment	1	1
Specification	2	2
Claims	3	3

	Applicant Arguments/Remarks Made in an Amendment	4	4

Warnings:

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Information:

7		00767861.PDF	88214	yes	18

Multipart Description

Doc Desc	Start	End
Specification	1	15
Claims	16	17
Abstract	18	18

Warnings:

Information:

8		00767854.PDF	87521	yes	18

Multipart Description

Doc Desc	Start	End
Specification	1	15
Claims	16	17
Abstract	18	18

Warnings:

Information:

9	Documents submitted with 371 Applications	00767913.PDF	56173	no	2

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Information:

10	Information Disclosure Statement (IDS) Filed	00767915.PDF	42219	no	3

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11	Foreign Reference	00767923.PDF	292421	no	9
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Information:					
12	Foreign Reference	00767928.PDF	80571	no	2
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Information:					
13	Foreign Reference	00767933.PDF	211742	no	5
Warnings:					
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Information:					
14	Foreign Reference	00767937.PDF	355854	no	10
Warnings:					
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Information:					
15	Foreign Reference	00767941.PDF	374283	no	10
Warnings:					
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Information:					
16	NPL Documents	00767943.PDF	51535	no	2
Warnings:					

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Information:

17	Fee Worksheet (PTO-875)	fee-info.pdf	8401	no	2

Warnings:

Information:

Total Files Size (in bytes):	2003162

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

Express Mail Label No. _____ Dated: _____

Docket No.: 20708/0204992-US0
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Yoshikazu Kuroumaru et al.

Application No.: National Phase of PCT/JP2004/017790

Confirmation No.: N/A

Filed: Concurrently Herewith

Art Unit: N/A

For: MOTOR-DRIVEN POWER STEERING APPARATUS

Examiner: Not Yet Assigned

FIRST PRELIMINARY AMENDMENT

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks/Arguments begin on page 4 of this paper.

OIPE
APR 24 2009
PATENT & TRADEMARK OFFICE

AMENDMENTS TO THE SPECIFICATION

Please amend the title as follows:

~~ELECTRIC POWER STEERING DEVICE~~ MOTOR-DRIVEN POWER STEERING APPARATUS

Following the title, please insert the following paragraphs:

CROSS-REFERENCE TO PRIOR APPLICATION

This is a U.S. National Phase Application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2004/017790 filed November 30, 2004, and claims the benefit of Japanese Patent Application No. 2003-409449 filed December 8, 2003 both of which are incorporated by reference herein. The International Application was published in Japanese on June 23, 2005 as WO 2005/056367 A1 under PCT Article 21(2).

Please replace the paragraph beginning on page 13, line 1, with the following rewritten paragraph:

-- FIG. 4 is a view showing a relation of the tooth surface stress σ_s and the tooth thickness of the tooth top with respect to the tooth depth h of the small gear 6, in the case of setting E to 206000 N/mm^2, P_n to 946, ~~N b~~ N_b to 14 mm, Z_1 to 10, Z_2 to 97, m to 0.95, the pressure angle α to 25 degrees, the torsion angle β to 25 degrees, d_b to 10.308 mm, α_b to 25.283 degrees, β_g to 22.521 degrees, and ~~Nb~~ N_b to 0.995. In FIG. 4, a circle mark indicates a tooth surface stress, and a rectangle mark indicates a value obtained by dividing the tooth thickness of the tooth top by the module value, respectively. --

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (Original): A motor-driven power steering apparatus in which a rotating torque of an electric motor is transmitted to a steering shaft by a drive gear provided in an output shaft of said electric motor and a driven gear provided in said steering shaft, and a speed reduction ratio is equal to or more than 3, wherein

said steering shaft and the output shaft of said electric motor are arranged in almost parallel, a center distance between both the shafts is equal to or more than 35 mm and equal to or less than 90 mm, and

said drive gear is configured such that a number of teeth is equal to or more than 6 and equal to or less than 15, a module is equal to or more than 0.8 and equal to or less than 1.5, a tooth depth is equal to or less than 2.4 times of the module, and a pressure angle is equal to or more than 14.5 degrees and equal to or less than 30 degrees, and a torsion angle is equal to or more than 0 degree and equal to or less than 40 degrees.

Claim 2 (Original): A motor-driven power steering apparatus as claimed in claim 1, wherein an involute gear in which a tooth profile is formed in such a manner that a pressure angle is increased from a tooth top of the gear to a tooth root is employed for one or both of said drive gear and said driven gear.

Claim 3 (Currently Amended): A motor-driven power steering apparatus as claimed in claim 1 ~~or 2~~, wherein an involute gear in which a crowning process is applied in a direction of a tooth trace is employed for one or both of said drive gear and said driven gear.

Claim 4 (New): A motor-driven power steering apparatus as claimed in claim 2, wherein an involute gear in which a crowning process is applied in a direction of a tooth trace is employed for one or both of said drive gear and said driven gear.

REMARKS

The title has been amended to be in conformance with the English translation of the International Application.

The specification has been amended in accordance with 37 CFR §1.78 to make reference to the International Application from which this application originates. Also the specification is amended to correct typographical errors. A mark up copy and a clean copy of the substitute specification are provided.

Claim 3 has been amended to eliminate multiply dependency. The amendment is made to reduce filing fees and not for any other reason related to patentability of such claims. No new matter has been added.

The claim fee was calculated based on the amended claims above. Please examine the application in view of the amendment set forth above.

Dated: June 8, 2006

Respectfully submitted,

By _____
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EXHIBIT B

[JP,11-124045,A]

PATENT ABSTRACTS OF JAPAN

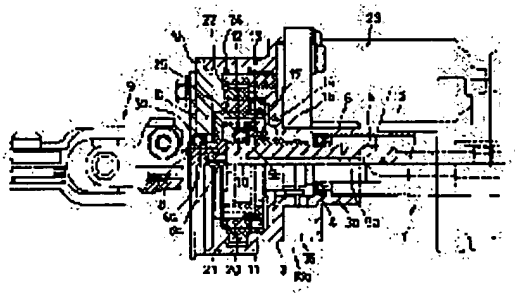
(11)Publication number : **11-124045**
(43)Date of publication of application : **11.05.1999**

(51)Int.Cl. B62D 5/04

(21)Application number : **10-245299**
(22)Date of filing : **31.08.1998**

(71)Applicant : **FUJI KIKO CO LTD**
(72)Inventor : **SHIBAYAMA KAZUYA**

(54) ELECTRICALLY POWERED STEERING DEVICE



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact electrically powered steering device using a gear with a tooth profile of a special theory.
SOLUTION: This device is configured so that it assists with the revolving of a steering shaft via a speed reduction mechanism comprised of an output gear of an electric motor fixed to the shaft. In this case, gears 21 and 22 of the speed reduction mechanism are formed by a spur gear or a helical gear with a tooth profile of special theory, and the speed reduction mechanism is contained in a housing 3 to support the respective gears so that they can rotate.

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]It is an electric power steering device with which rotation of a steering shaft is assisted via a deceleration mechanism which consists of a collar gear and an output-tooth car of an electric motor which were fixed to a shaft, An electric power steering device characterized by storing a deceleration mechanism in housing while forming said deceleration mechanism with a spur wheel or a helical gear of a couple set as a high reduction ratio.
[Claim 2]The electric power steering device according to claim 1 forming a tooth profile of a gear in said deceleration mechanism with a special theory tooth profile.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the electric power steering device in a car, and relates to the electric power steering device which used the spur wheel or the helical gear especially for that deceleration mechanism.
[0002]
[Description of the Prior Art]The power steering device of a car is a device which reduces the operating physical force of a steering wheel and raises steering performance.
Although oil pressure is generally used, if it is in a minivehicle etc., the electric power steering device using an electric motor is provided.
[0003]He is trying for the conventional electric power steering device to rotate a steering shaft for rotation of an electric motor via worm gear. Since this deceleration mechanism had the low torque transmission efficiency of worm gear (60 to 80%), eternal, then bigger motor output torque was needed in the moderating ratio and the motor outer diameter became large as a result, there was a problem that miniaturization was missing. Then, a motor for driving is attached to a column and parallel, and what uses a spur wheel as a deceleration mechanism is provided plentifully (references, such as JP,62-144773,U and JP,58-149255,U).
[0004]
[Problem(s) to be Solved by the Invention]If a spur wheel is used, since torque transmission efficiency is high (about 95%), the part motor output torque will decrease and miniaturization of a motor will be attained. However, when this deceleration mechanism tended to form the moderating ratio which needs a motor pinion gear and the gear which gears to it in one step, the outer diameter of the follower side gear became large, and it had a problem which says that miniaturization is still missing. When 1 stage constitution is given up and the middle gear was made to intervene, there were an increase in backlash and a new problem of a cost hike (refer to JP,1-145668,U).
[0005]Then, this invention tries to attain that miniaturization in the electric power steering device which has arranged the electric motor and the deceleration mechanism to the steering column which fixes a steering wheel to an end.
[0006]
[Means for Solving the Problem]In order to solve an aforementioned problem, this invention is an electric power steering device with which rotation of a steering shaft is assisted via a

deceleration mechanism which consists of a collar gear and an output-tooth car of an electric motor which were fixed to a shaft, While forming said deceleration mechanism with a spur wheel or a helical gear of a couple set as a high reduction ratio, It is characterized by storing a deceleration mechanism in housing, and a deceleration mechanism is formed using a spur wheel or a helical gear of a couple set as a high reduction ratio, Since housing can be approached and an electric motor can be formed by storing this in housing, the miniaturization can be attained in a steering column which has arranged an electric motor and a deceleration mechanism to a steering column.

[0007]

[Embodiment of the Invention]the following -- this embodiment of the invention -- an example is explained based on figures. As shown in drawing 1 and 2, while attaching the cylinder part 3a in the lower end part of the ROAJA blanket 2 of the steering column 1 and fixing the housing 3 to it, The steering shaft 5 is supported movably by the cylinder part 3a via the bearing 4, enabling free rotation, the lower end part of the steering shaft 5 intervenes the bearing 4a, and is supported movably with the end plate 3b, and the end plate 3b is attached in the housing 3.

[0008]The boss 5a is formed in the lower end part of the steering shaft 5, in this boss 5a, the torsion bar spring 6 is inserted and that upper bed part is connected by the pin 7. The shaft 8 which has the hole 8a which the serration 6a was formed in the peripheral face of the lower end part of the torsion bar spring 6, and formed this serration 6a and the engaged serration in inner skin is connected.

[0009]The end face of the shaft 8 and the steering shaft 5 has a predetermined interval, and is carrying out variant fitting, if the rotational difference of the steering shaft 5 and the shaft 8 becomes a predetermined value, it will contact, and transfer of direct torque is performed. The shaft 8 is concluded by the adjustable joint 9 by serration engagement. An intermediate shaft (graphic display abbreviation) is connected with the adjustable joint 9, and it is connected to this intermediate shaft in a steering gear box. The upper bed part of the steering shaft 5 penetrates the ROAJA blanket 2, and the steering wheel (graphic display abbreviation) is attached pivotally by the upper bed part.

[0010]The publicly known sensor mechanism is formed in said housing 3. That is, fitting adherence of the shaft 10 with a built-in sensor of a cylinder-like-object-with-base form is carried out at the shaft 8, and this shaft 10 with a built-in sensor is supported movably by the housing 3 pivotable via the bearing 11. The coil spring 12 welded by pressure to the inner bottom of the shaft 10 with a built-in sensor, and in the shaft 8 neighborhood, via the color 14, the ring 13 of the section L type which contacts this coil spring 12 has fitted into the steering column 5 so that axial movement is possible.

[0011]The sliding color 15 which fits into the steering shaft 5 so that axial movement is possible engages with the color 14, and the sensor arm 16a of the potentiometer 16 is engaging with the circumferential groove provided in this sliding color 15. And for relativity is carried out to the peripheral surface of the color 14 in a diametral direction, the hole 17 is formed, and the ball 18 of the equal diameter is mostly inserted into this hole 17. On the other hand, for [of the slot 5b of section semicircular shapes which the ball 18 rolls] relativity is carried out to the steering shaft 5 which faces the sliding color 15 in a diametral direction, and it has formed in the shape of an approximately whorl.

[0012]The controller 19 is arranged in parallel with the steering column 1 via the bracket 40 fixed to the upper part side of a steering column by the housing 3, as shown in drawing 2. The controller 19 can be stored in the lower part of the instrument panel 41.

[0013]Subsequently, the iron ring 20 is pressed fit and attached in the shaft 10 with a built-in sensor, and integral moulding of the collar gear 21 which consists of the spur wheel or helical gear of a special theory tooth profile made of resin is carried out to the peripheral part of this iron ring 20. And the output-tooth car (motor pinion gear) 22 which consists of the spur wheel or helical gear of a special theory tooth profile which meshes with this collar gear 21 was supported pivotally by the housing 3 pivotable, and this output-tooth vehicle 22 is projected from the electric motor 23. The electric motor 23 is arranged at a steering column and parallel at the housing 3.

[0014]In order to hold highly the accuracy of the distance between axial centers of the shaft 10 with a built-in sensor, and the output-tooth vehicle 22, the guide plate 24 is fitted into the shaft 10 with a built-in sensor rotatable, and the slip off stop of this guide plate 24 is carried out with C ring 25. The end of the output-tooth vehicle 22 fits into the edge part of the guide plate 24 pivotable. Therefore, thereby, the distance between axial centers of the output-tooth vehicle 22 and the shaft 10 with a built-in sensor raises the endurance of the gear, without being uniformly held with sufficient accuracy and changing.

[0015]The iron ring 20 pressed fit in the shaft 10 with a built-in sensor will be set up produce a slip if the torque which acts on the gear exceeds a predetermined value. Namely, it is operating a steering wheel by the power beyond a predetermined value, when the electric motor's 23 locks although a slip is not produced in the driving torque of the usual electric motor 23, A slip is produced between the shaft 10 with a built-in sensor, and the iron ring 20, and steering from a steering wheel is enabled.

[0016]Therefore, if the steering shaft 5 is rotated via a steering wheel in a shaft center for steering, The steering shaft 5 rotates twisting the torsion bar spring 6, According to the rotational difference of the steering shaft 5 by torsion of this torsion bar spring 6, and the shaft 10 with a built-in sensor. When approximately whorl-like the slot 5b and the ball 18 are passed, and the color 14 and the sliding color 15 compress or elongate the coil spring 12 and move to the shaft orientations of the steering shaft 5, The sensor arm 16a of the potentiometer 16 detects the RRC or RLC of the steering shaft 5, and inputs this signal into the controller 19. The controller 19 orders the electric motor 23 the drive of positive rotation or counterrotation. Therefore, a counterrotation drive is carried out and the electric motor 23 rotates the shaft 10 with a built-in sensor in positive rotation or the direction which the output-tooth vehicle 22 rotates the collar gear 21, and abolishes torsion of the torsion bar spring 6. Therefore, mitigation of the power of rotating a steering wheel is made.

[0017]Next, if other examples of an embodiment of this invention are explained, as shown in drawing 3, the cylinder part 31 of the housing 30 is fitted in and fixed to the lower end part of the ROAJA blanket 2, and the electric motors 33 and 33 are fixed to the motor holding parts 32 and 32 which were used as this housing 30 for relativity, and were formed in it in the diametral direction, respectively. The output-tooth vehicle 34 of the electric motor 33 is a spur wheel of a special theory tooth profile, and is projected into the housing 30 from the bore formed in the motor holding part 32. The number of the electric motors 33 is two or more plurality, and is arranged with a constant interval to the hoop direction of the housing 30. The electric motor 33 is controlled by a controller like a precedent.

[0018]On the other hand, the shaft 8 is connected with the lower end part of the steering shaft 5 via the torsion bar spring 6 like a precedent, and the adjustable joint 9 is connected with the shaft 8. The iron ring 20 is pressed fit in the shaft 10 with a built-in sensor fixed to the shaft 8, integral moulding of the collar gear 21 which consists of a spur wheel of the special theory tooth profile

made of resin is carried out to the iron ring 20, and said two or more output-tooth vehicles 34 gear with this collar gear 21. The shaft 10 with a built-in sensor inputs torsion of the torsion bar spring 6 into a controller relating with the parts which form a sensor like a precedent.
[0019]the distance between axial centers of the steering shaft 5 and the output-tooth vehicle 34 -- always -- fixed -- accuracy -- in order to hold highly, the guide plate 35 is fitted into the shaft 10 with a built-in sensor rotatable, and a slip off stop is carried out for this guide plate 35 with C ring 25. The guide plate 35 has a bore which fits in two or more output-tooth vehicles 34 pivotable. Although not illustrated in the steering shaft 5, it is the same as a precedent that an intermediate shaft is connected with a lower end part via an adjustable joint, and a steering wheel is attached pivotally by the upper bed part.
[0020]Then, for steering, if a steering wheel is rotated, the steering shaft 5 will rotate, When the controller 19 which torsion arose and detected this drives the electric motor 33 to the torsion bar spring 6, the output-tooth vehicle 34 makes it rotate the collar gear 21 and the shaft 10 with a built-in sensor rotates, In order that the adjustable joint 9 may rotate via the shaft 8, mitigation of the power of rotating a steering wheel is made.
[0021]And when you need the torque of the steering shaft 5 greatly, while making it drive two or more electric motors 33 and 33 of all, it is controllable by the controller 6 to make any one electric motor 33 drive, when small torque is sufficient. Thereby, since output torque of the one electric motor 33 can be made small, the miniaturization of the electric motor 33 can be attained.
[0022]When the gear of the special theory tooth profile was explained, as this gear is the high durability gear-tooth gear borne by a new tooth profile theory and it was shown in drawing 4, The collar gear 21 of the driving side which all comes out of the output-tooth vehicle 22, has the tooth part 22a of six sheets, and gears with this all starts, for example, has the tooth part 21a of 50 sheets, and is constituted. The curvature of a tooth curve is a gear-tooth gear being the continuation and the differentiable function which are periodically fluctuated in the direction of a gear-tooth bamboo, and it is the publicly known gear published by JP,2-15743,B.
[0023]Then, when quoting the outline of the gear of this special theory tooth profile from Mr. Tsutomu Komori's paper (machine design magazine of the 1990 issue), as it was shown in drawing 5, a basic rack tooth profile is arranged so that it may become point symmetry to an intersection with pitch line P.L. By considering it as point symmetry, a root-of-tooth part becomes a concave surface, and an addendum part becomes a convex. This basic rack tooth profile comprises an involute curve continuously divided into minute intervals, and shows the details of the several-numbered (the i-th) involute curve into which between mn shown as the solid line was divided. Between ms(es), it is an involute curve made from the base circle of the radius Gt centering on Ogt, and is an involute curve made from the base circle of the radius G1 centering on Og't between sn(s). The center of curvature in mn point on a tooth profile is located on a pitch line. The length between mn(s) is adjusted with the size of the angle delta which is a parameter of a pressure angle.
[0024]Drawing 6 is a figure in which the involute curve divided into minute intervals shows the process connected. ******** is an involute curve connected with the above-mentioned mn. The conditions which ****** before and behind this connects to m point or n point have an equal curvature radius at m point or n point, and are that that center is on a pitch line. The size of the base circle radius Gt is made into the function of a pressure angle, and changes to Gt+2 from Gt. Also at n' point of the figure, a center of curvature is on a pitch line, repeats this pattern henceforth, and forms the rack tooth profile.
[0025]Drawing 7 is the basic rack tooth profile drawn according to the above-mentioned

principle. The slash shows the curvature radius of the spot weld of the involute curve divided into the small section. As shown also in a figure, many centers of curvature of a tooth profile exist on a pitch line. When this rack tooth profile is transposed to a rack tool (hob tooth profile) and is considered, as for the gear-tooth gear by which gear cutting was carried out by this rack tool, many centers of curvature of a tooth profile will exist on a pitch circle. Therefore, in engagement of the gear-tooth gear of a couple, relative curvature is 0 in all the nodes, and it becomes engagement with a concave surface and a convex.

[0026]While arranging an electric motor and a steering column in parallel and forming the gear of a deceleration mechanism with the spur wheel or helical gear of a special theory tooth profile according to the above-mentioned invention in this way, Since the guide plate which fits in the axis of the output-tooth vehicle in the housing which stores a deceleration mechanism, and a collar gear pivotable, respectively was provided, the outer diameter of a gear becomes small, therefore it becomes miniaturizable [an electric steering device].

[0027]Since it was made to raise the accuracy of the distance between axial centers of an output-tooth vehicle and a collar gear by using a guide plate, the endurance of the gear improves. And since the spur wheel or the helical gear was made the deceleration mechanism, it takes it, and torque transmission efficiency becomes high and can decrease the part and motor output torque, a miniaturization and low-cost-izing of an electric motor can be performed.

[0028]While the gear of resin is really formed in the peripheral part of an iron ring, a collar gear, An iron ring is pressed fit in a shaft, since it will slip between an iron ring and a shaft if the torque which acts on the gear exceeds a predetermined value, even when an electric motor locks, a steering wheel should be operated and steering torque should be transmitted. Therefore, the clutch which was being used conventionally can be abolished and, thereby, low cost-ization can be performed.

[0029]By unifying a controller on housing, for example regardless of positions of the conventional controller, such as the glove box bottom of a passenger seat, ** is also good and can be miniaturized as a unit.

[0030]

[Effect of the Invention]According to this invention explained above, it is an electric power steering device with which rotation of a steering shaft is assisted via the deceleration mechanism which consists of the collar gear and the output-tooth car of an electric motor which were fixed to the shaft, Since said deceleration mechanism was formed with the spur wheel or helical gear of the couple set as the high reduction ratio and this deceleration mechanism is stored in housing, Housing can be approached, an electric motor can be formed and the miniaturization can be attained in the steering column which has arranged the electric motor and the deceleration mechanism to the steering column.

[0031]And by using the spur wheel of a special theory tooth profile, torque transmission efficiency becomes high, the part motor output torque decreases and miniaturization of a motor is attained. Therefore, the moderating ratio which needs a motor pinion gear and the gear which gears to it in one step can be formed, the outer diameter of a gear becomes small, therefore this deceleration mechanism becomes miniaturizable [an electric steering device].

TECHNICAL FIELD

[Field of the Invention]This invention relates to the electric power steering device in a car, and relates to the electric power steering device which used the spur wheel or the helical gear especially for that deceleration mechanism.

PRIOR ART

[Description of the Prior Art]The power steering device of a car is a device which reduces the operating physical force of a steering wheel and raises steering performance.
Although oil pressure is generally used, if it is in a minivehicle etc., the electric power steering device using an electric motor is provided.
[0003]He is trying for the conventional electric power steering device to rotate a steering shaft for rotation of an electric motor via worm gear. Since this deceleration mechanism had the low torque transmission efficiency of worm gear (60 to 80%), eternal, then bigger motor output torque was needed in the moderating ratio and the motor outer diameter became large as a result, there was a problem that miniaturization was missing. Then, a motor for driving is attached to a column and parallel, and what uses a spur wheel as a deceleration mechanism is provided plentifully (references, such as JP,62-144773,U and JP,58-149255,U).

EFFECT OF THE INVENTION

[Effect of the Invention]It is an electric power steering device which assists rotation of a steering shaft with this invention explained above via the deceleration mechanism which consists of the collar gear and the output-tooth car of an electric motor which were fixed to the shaft, Said deceleration mechanism was formed with the spur wheel or helical gear of the couple set as the high reduction ratio, and this deceleration mechanism is stored in housing.
Therefore, housing can be approached, an electric motor can be formed and the miniaturization can be attained in the steering column which has arranged the electric motor and the deceleration mechanism to the steering column.

[0031]And by using the spur wheel of a special theory tooth profile, torque transmission efficiency becomes high, the part motor output torque decreases and miniaturization of a motor is attained. Therefore, the moderating ratio which needs a motor pinion gear and the gear which gears to it in one step can be formed, the outer diameter of a gear becomes small, therefore this deceleration mechanism becomes miniaturizable [an electric steering device].

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]If a spur wheel is used, since torque transmission efficiency is high (about 95%), the part motor output torque will decrease and miniaturization of a motor will be attained. However, when this deceleration mechanism tended to form the moderating ratio which needs a motor pinion gear and the gear which gears to it in one step, the outer diameter of the follower side gear became large, and it had a problem which says that miniaturization is still missing. When 1 stage constitution is given up and the middle gear was

made to intervene, there were an increase in backlash and a new problem of a cost hike (refer to JP,1-145668,U).
[0005]Then, this invention tries to attain that miniaturization in the electric power steering device which has arranged the electric motor and the deceleration mechanism to the steering column which fixes a steering wheel to an end.
[0006]

MEANS

[Means for Solving the Problem]In order to solve an aforementioned problem, this invention is an electric power steering device with which rotation of a steering shaft is assisted via a deceleration mechanism which consists of a collar gear and an output-tooth car of an electric motor which were fixed to a shaft, While forming said deceleration mechanism with a spur wheel or a helical gear of a couple set as a high reduction ratio, It is characterized by storing a deceleration mechanism in housing, and a deceleration mechanism is formed using a spur wheel or a helical gear of a couple set as a high reduction ratio, Since housing can be approached and an electric motor can be formed by storing this in housing, the miniaturization can be attained in a steering column which has arranged an electric motor and a deceleration mechanism to a steering column.
[0007]
[Embodiment of the Invention]the following -- this embodiment of the invention -- an example is explained based on figures. As shown in drawing 1 and 2, while attaching the cylinder part 3a in the lower end part of the ROAJA blanket 2 of the steering column 1 and fixing the housing 3 to it, The steering shaft 5 is supported movably by the cylinder part 3a via the bearing 4, enabling free rotation, the lower end part of the steering shaft 5 intervenes the bearing 4a, and is supported movably with the end plate 3b, and the end plate 3b is attached in the housing 3.
[0008]The boss 5a is formed in the lower end part of the steering shaft 5, in this boss 5a, the torsion bar spring 6 is inserted and that upper bed part is connected by the pin 7. The shaft 8 which has the hole 8a which the serration 6a was formed in the peripheral face of the lower end part of the torsion bar spring 6, and formed this serration 6a and the engaged serration in inner skin is connected.
[0009]The end face of the shaft 8 and the steering shaft 5 has a predetermined interval, and is carrying out variant fitting, if the rotational difference of the steering shaft 5 and the shaft 8 becomes a predetermined value, it will contact, and transfer of direct torque is performed. The shaft 8 is concluded by the adjustable joint 9 by serration engagement. An intermediate shaft (graphic display abbreviation) is connected with the adjustable joint 9, and it is connected to this intermediate shaft in a steering gear box. The upper bed part of the steering shaft 5 penetrates the ROAJA blanket 2, and the steering wheel (graphic display abbreviation) is attached pivotally by the upper bed part.
[0010]The publicly known sensor mechanism is formed in said housing 3. That is, fitting adherence of the shaft 10 with a built-in sensor of a cylinder-like-object-with-base form is carried out at the shaft 8, and this shaft 10 with a built-in sensor is supported movably by the housing 3 pivotable via the bearing 11. The coil spring 12 welded by pressure to the inner bottom of the shaft 10 with a built-in sensor, and in the shaft 8 neighborhood, via the color 14, the ring 13 of the section L type which contacts this coil spring 12 has fitted into the steering column 5 so

that axial movement is possible.
[0011]The sliding color 15 which fits into the steering shaft 5 so that axial movement is possible engages with the color 14, and the sensor arm 16a of the potentiometer 16 is engaging with the circumferential groove provided in this sliding color 15. And for relativity is carried out to the peripheral surface of the color 14 in a diametral direction, the hole 17 is formed, and the ball 18 of the equal diameter is mostly inserted into this hole 17. On the other hand, for [of the slot 5b of section semicircular shapes which the ball 18 rolls] relativity is carried out to the steering shaft 5 which faces the sliding color 15 in a diametral direction, and it has formed in the shape of an approximately whorl.
[0012]The controller 19 is arranged in parallel with the steering column 1 via the bracket 40 fixed to the upper part side of a steering column by the housing 3, as shown in drawing 2. The controller 19 can be stored in the lower part of the instrument panel 41.
[0013]Subsequently, the iron ring 20 is pressed fit and attached in the shaft 10 with a built-in sensor, and integral moulding of the collar gear 21 which consists of the spur wheel or helical gear of a special theory tooth profile made of resin is carried out to the peripheral part of this iron ring 20. And the output-tooth car (motor pinion gear) 22 which consists of the spur wheel or helical gear of a special theory tooth profile which meshes with this collar gear 21 was supported pivotally by the housing 3 pivotable, and this output-tooth vehicle 22 is projected from the electric motor 23. The electric motor 23 is arranged at a steering column and parallel at the housing 3.
[0014]In order to hold highly the accuracy of the distance between axial centers of the shaft 10 with a built-in sensor, and the output-tooth vehicle 22, the guide plate 24 is fitted into the shaft 10 with a built-in sensor rotatable, and the slip off stop of this guide plate 24 is carried out with C ring 25. The end of the output-tooth vehicle 22 fits into the edge part of the guide plate 24 pivotable. Therefore, thereby, the distance between axial centers of the output-tooth vehicle 22 and the shaft 10 with a built-in sensor raises the endurance of the gear, without being uniformly held with sufficient accuracy and changing.
[0015]The iron ring 20 pressed fit in the shaft 10 with a built-in sensor will be set up produce a slip if the torque which acts on the gear exceeds a predetermined value. Namely, it is operating a steering wheel by the power beyond a predetermined value, when the electric motor's 23 locks although a slip is not produced in the driving torque of the usual electric motor 23, A slip is produced between the shaft 10 with a built-in sensor, and the iron ring 20, and steering from a steering wheel is enabled.
[0016]Therefore, if the steering shaft 5 is rotated via a steering wheel in a shaft center for steering, The steering shaft 5 rotates twisting the torsion bar spring 6, According to the rotational difference of the steering shaft 5 by torsion of this torsion bar spring 6, and the shaft 10 with a built-in sensor. When approximately whorl-like the slot 5b and the ball 18 are passed, and the color 14 and the sliding color 15 compress or elongate the coil spring 12 and move to the shaft orientations of the steering shaft 5, The sensor arm 16a of the potentiometer 16 detects the RRC or RLC of the steering shaft 5, and inputs this signal into the controller 19. The controller 19 orders the electric motor 23 the drive of positive rotation or counterrotation. Therefore, a counterrotation drive is carried out and the electric motor 23 rotates the shaft 10 with a built-in sensor in positive rotation or the direction which the output-tooth vehicle 22 rotates the collar gear 21, and abolishes torsion of the torsion bar spring 6. Therefore, mitigation of the power of rotating a steering wheel is made.
[0017]Next, if other examples of an embodiment of this invention are explained, as shown in

drawing 3, the cylinder part 31 of the housing 30 is fitted in and fixed to the lower end part of the ROAJA blanket 2, and the electric motors 33 and 33 are fixed to the motor holding parts 32 and 32 which were used as this housing 30 for relativity, and were formed in it in the diametral direction, respectively. The output-tooth vehicle 34 of the electric motor 33 is a spur wheel of a special theory tooth profile, and is projected into the housing 30 from the bore formed in the motor holding part 32. The number of the electric motors 33 is two or more plurality, and is arranged with a constant interval to the hoop direction of the housing 30. The electric motor 33 is controlled by a controller like a precedent.

[0018]On the other hand, the shaft 8 is connected with the lower end part of the steering shaft 5 via the torsion bar spring 6 like a precedent, and the adjustable joint 9 is connected with the shaft 8. The iron ring 20 is pressed fit in the shaft 10 with a built-in sensor fixed to the shaft 8, integral moulding of the collar gear 21 which consists of a spur wheel of the special theory tooth profile made of resin is carried out to the iron ring 20, and said two or more output-tooth vehicles 34 gear with this collar gear 21. The shaft 10 with a built-in sensor inputs torsion of the torsion bar spring 6 into a controller relating with the parts which form a sensor like a precedent.

[0019]the distance between axial centers of the steering shaft 5 and the output-tooth vehicle 34 -- always -- fixed -- accuracy -- in order to hold highly, the guide plate 35 is fitted into the shaft 10 with a built-in sensor rotatable, and a slip off stop is carried out for this guide plate 35 with C ring 25. The guide plate 35 has a bore which fits in two or more output-tooth vehicles 34 pivotable. Although not illustrated in the steering shaft 5, it is the same as a precedent that an intermediate shaft is connected with a lower end part via an adjustable joint, and a steering wheel is attached pivotally by the upper bed part.

[0020]Then, for steering, if a steering wheel is rotated, the steering shaft 5 will rotate, When the controller 19 which torsion arose and detected this drives the electric motor 33 to the torsion bar spring 6, the output-tooth vehicle 34 makes it rotate the collar gear 21 and the shaft 10 with a built-in sensor rotates, In order that the adjustable joint 9 may rotate via the shaft 8, mitigation of the power of rotating a steering wheel is made.

[0021]And when you need the torque of the steering shaft 5 greatly, while making it drive two or more electric motors 33 and 33 of all, it is controllable by the controller 6 to make any one electric motor 33 drive, when small torque is sufficient. Thereby, since output torque of the one electric motor 33 can be made small, the miniaturization of the electric motor 33 can be attained.

[0022]When the gear of the special theory tooth profile was explained, as this gear is the high durability gear-tooth gear borne by a new tooth profile theory and it was shown in drawing 4, The collar gear 21 of the driving side which all comes out of the output-tooth vehicle 22, has the tooth part 22a of six sheets, and gears with this all starts, for example, has the tooth part 21a of 50 sheets, and is constituted. The curvature of a tooth curve is a gear-tooth gear being the continuation and the differentiable function which are periodically fluctuated in the direction of a gear-tooth bamboo, and it is the publicly known gear published by JP,2-15743,B.

[0023]Then, when quoting the outline of the gear of this special theory tooth profile from Mr. Tsutomu Komori's paper (machine design magazine of the 1990 issue), as it was shown in drawing 5, a basic rack tooth profile is arranged so that it may become point symmetry to an intersection with pitch line P.L. By considering it as point symmetry, a root-of-tooth part becomes a concave surface, and an addendum part becomes a convex. This basic rack tooth profile comprises an involute curve continuously divided into minute intervals, and shows the details of the several-numbered (the i-th) involute curve into which between mn shown as the solid line was divided. Between ms(es), it is an involute curve made from the base circle of the

radius Gt centering on Ogt, and is an involute curve made from the base circle of the radius G1 centering on Og't between sn(s). The center of curvature in mn point on a tooth profile is located on a pitch line. The length between mn(s) is adjusted with the size of the angle delta which is a parameter of a pressure angle.

[0024]Drawing 6 is a figure in which the involute curve divided into minute intervals shows the process connected. ******** is an involute curve connected with the above-mentioned mn. The conditions which ****** before and behind this connects to m point or n point have an equal curvature radius at m point or n point, and are that that center is on a pitch line. The size of the base circle radius Gt is made into the function of a pressure angle, and changes to Gt+2 from Gt. Also at n' point of the figure, a center of curvature is on a pitch line, repeats this pattern henceforth, and forms the rack tooth profile.

[0025]Drawing 7 is the basic rack tooth profile drawn according to the above-mentioned principle. The slash shows the curvature radius of the spot weld of the involute curve divided into the small section. As shown also in a figure, many centers of curvature of a tooth profile exist on a pitch line. When this rack tooth profile is transposed to a rack tool (hob tooth profile) and is considered, as for the gear-tooth gear by which gear cutting was carried out by this rack tool, many centers of curvature of a tooth profile will exist on a pitch circle. Therefore, in engagement of the gear-tooth gear of a couple, relative curvature is 0 in all the nodes, and it becomes engagement with a concave surface and a convex.

[0026]While arranging an electric motor and a steering column in parallel and forming the gear of a deceleration mechanism with the spur wheel or helical gear of a special theory tooth profile according to the above-mentioned invention in this way, Since the guide plate which fits in the axis of the output-tooth vehicle in the housing which stores a deceleration mechanism, and a collar gear pivotable, respectively was provided, the outer diameter of a gear becomes small, therefore it becomes miniaturizable [an electric steering device].

[0027]Since it was made to raise the accuracy of the distance between axial centers of an output-tooth vehicle and a collar gear by using a guide plate, the endurance of the gear improves. And since the spur wheel or the helical gear was made the deceleration mechanism, it takes it, and torque transmission efficiency becomes high and can decrease the part and motor output torque, a miniaturization and low-cost-izing of an electric motor can be performed.

[0028]While the gear of resin is really formed in the peripheral part of an iron ring, a collar gear, An iron ring is pressed fit in a shaft, since it will slip between an iron ring and a shaft if the torque which acts on the gear exceeds a predetermined value, even when an electric motor locks, a steering wheel should be operated and steering torque should be transmitted. Therefore, the clutch which was being used conventionally can be abolished and, thereby, low cost-ization can be performed.

[0029]By unifying a controller on housing, for example regardless of positions of the conventional controller, such as the glove box bottom of a passenger seat, ** is also good and can be miniaturized as a unit.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

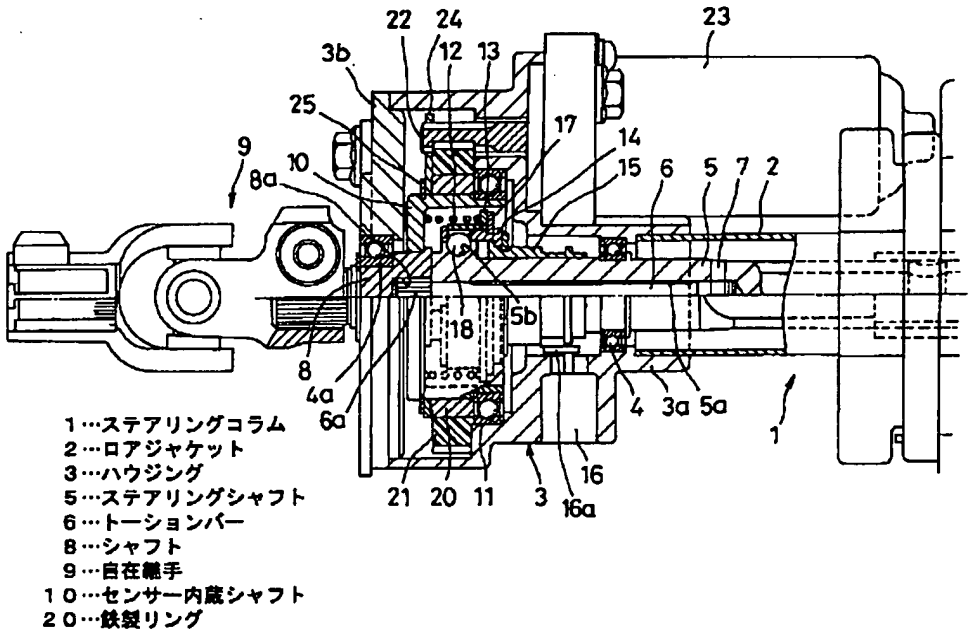
[Drawing 1]this embodiment of the invention -- the section top view showing an example

[Drawing 2]The section side view of drawing 1

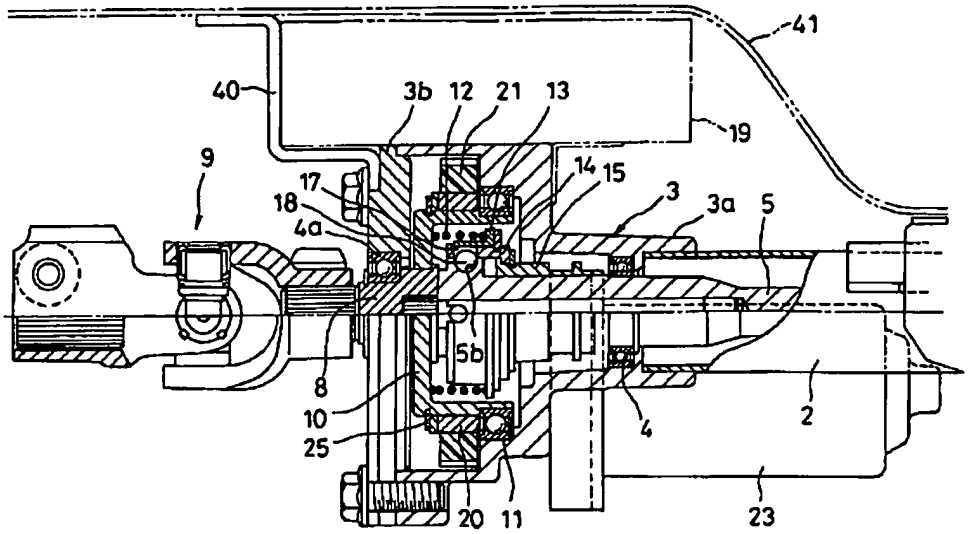
[Drawing 3]The section top view showing other examples of an embodiment of this invention
[Drawing 4]The tooth profile figure of the special theory tooth profile gear
[Drawing 5]The explanatory view of the theory of a special theory tooth profile
[Drawing 6]The explanatory view of the theory of a special theory tooth profile
[Drawing 7]The explanatory view of the theory of a special theory tooth profile
[Description of Notations]
1 -- Steering column
2 -- ROAJA blanket
3 -- Housing
5 -- Steering shaft
6 -- Torsion bar spring
8 -- Shaft
9 -- Adjustable joint
10 -- Shaft with a built-in sensor
20 -- Iron ring

DRAWINGS

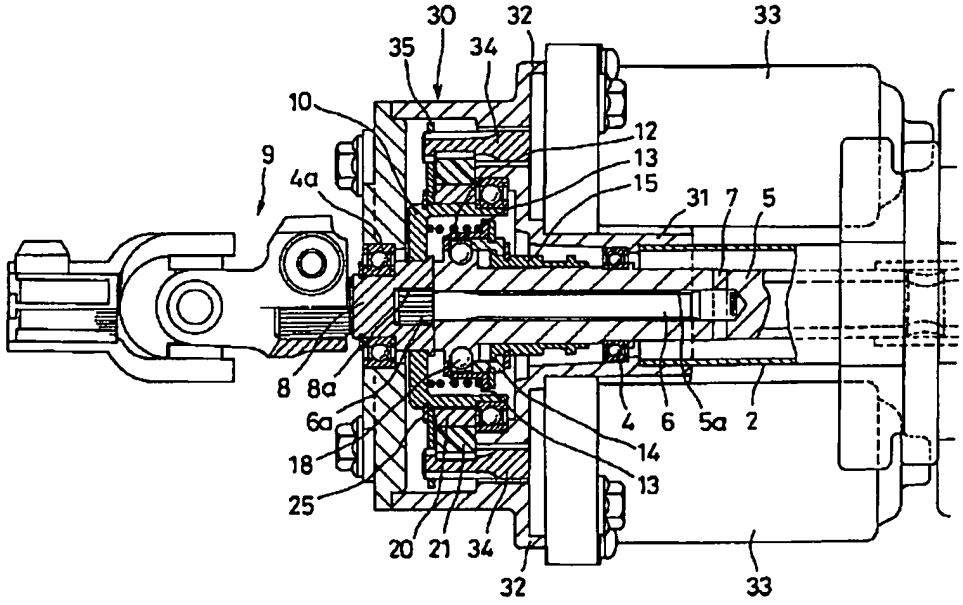
[Drawing 1]



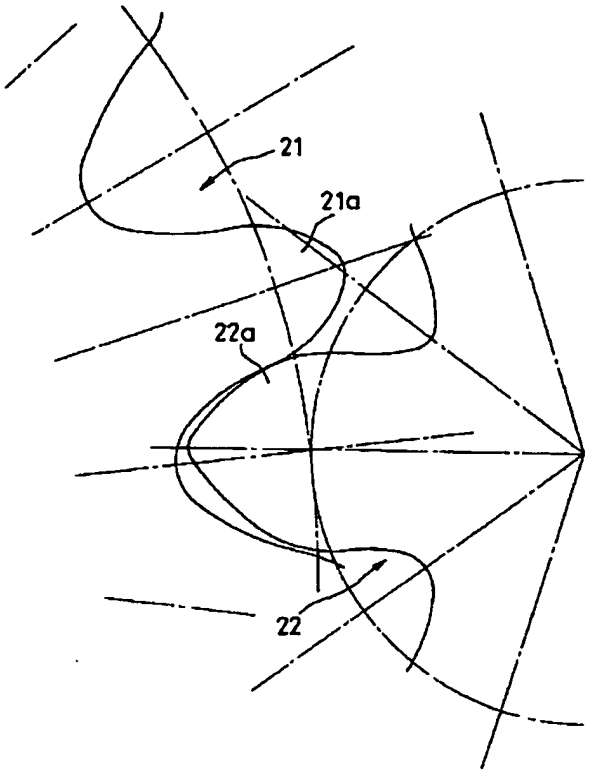
[Drawing 2]



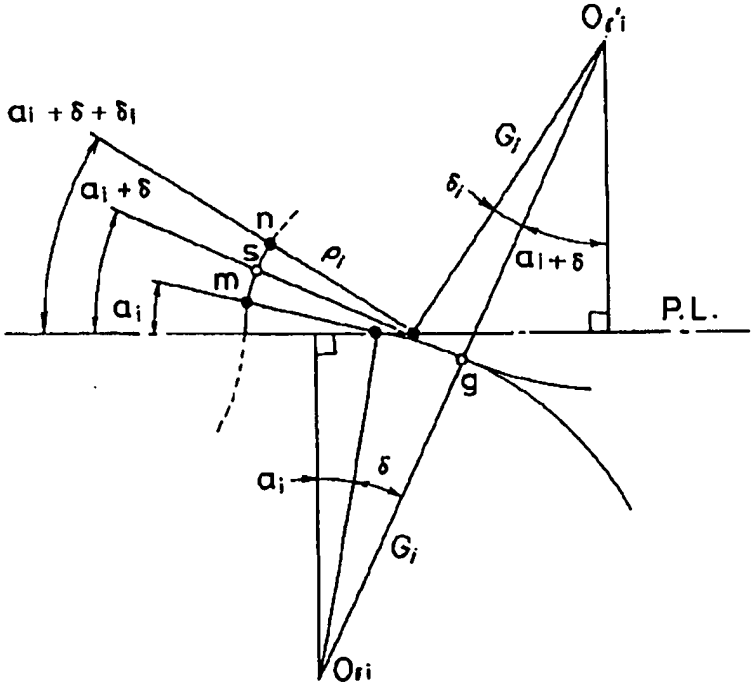
[Drawing 3]



[Drawing 4]



[Drawing 5]



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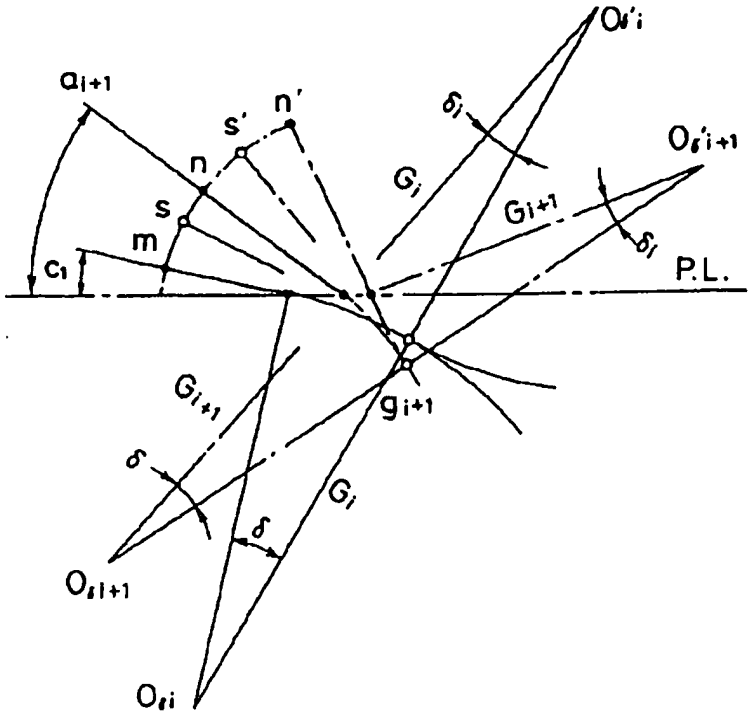
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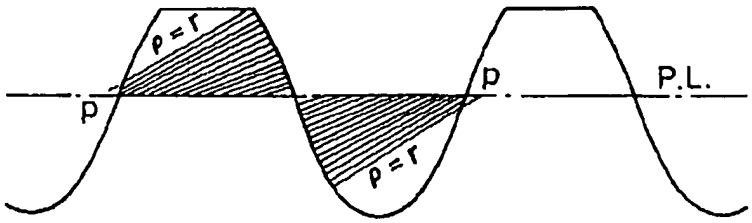
[Drawing 7]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